the velocity changes from $\frac{9}{10}u_1 + \frac{1}{10}u_2$ to $\frac{1}{10}u_1 + \frac{9}{10}u_2$. Substituting these values for u in (7)

$$T = \frac{Qu_1 - S}{M(u_1 - u_2)} \cdot 2\log_e 9,$$

and inserting the values of γ, ρ, μ, and κ for air,

$$\gamma = 1{\cdot}4, \qquad \rho = 1{\cdot}3 \times 10^{-3}, \qquad \mu = 1{\cdot}9 \times 10^{-4}, \qquad \kappa = \frac{1{\cdot}6\mu R}{J(\gamma - 1)},*$$

there is obtained $(Qu_1 - S)/M = 0{\cdot}22$ and $T = (u_1 - u_2)^{-1}$ approximately.

In the case of waves of percussion it is known that the velocity differs appreciably from that of sound. In that case $u_1 - u_2$ would be considerable and its reciprocal would be small, so that the motion would closely approximate to an abrupt discontinuous one. In the case of ordinary sounds, however, the relative velocities of air in different parts of a wave are small, so that T would be large compared with a wave-length, and nothing in the nature of a sharp discontinuity would ever be established.

On the Radium Content of Basalt.

By the Hon. R. J. Strutt, F.R.S., Professor of Physics, Imperial College of Science, South Kensington.

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In a former paper† I gave measurements of the amount of radium in representative igneous rocks. In the reduction of these measurements a value of the equilibrium ratio between radium and uranium given by Rutherford and Boltwood was used, which has subsequently been corrected by those authors. My results were reprinted with the necessary amendment by Eve and McIntosh.‡

Subsequent to the publication of my first paper other experimenters have made similar measurements, with results in most cases substantially the same.§

Prof. J. Joly, however, has arrived at values considerably higher. His results are most conveniently referred to in his book "Radioactivity and

* O. E. Meyer, 'Kinetic Theory of Gases,' English edition, p. 292.

† 'Roy. Soc. Proc.,' A, vol. 77, p. 472.

‡ 'Phil. Mag.,' August, 1907, p. 231.

§ See Eve and McIntosh, *loc. cit.* Farr and Florance, 'Phil. Mag.,' November, 1909, p. 812. Schlundt and Moore, 'U.S. Geol. Survey Bull.,' vol. 395, p. 26. Fletcher, 'Phil. Mag.,' July, 1910, p. 36.

Geology" (Constable, 1909). The discrepancy is most marked in the case of basalts, for which he finds a value of $4{\cdot}9 \times 10^{-12}$ gramme radium per gramme of rock. My own results average about $0{\cdot}6 \times 10^{-12}$, as also do those of the other experimenters. Prof. Joly does not find much difference between acid and basic rocks. Other experimenters have all found that acid rocks tend to be considerably richer.

I have made some additional measurements on basalts, in order, if possible, to clear up the cause of this discrepancy.

Special attention was paid to a point which had perhaps not been adequately considered in the earlier investigation. When the rock has been fused with sodium carbonate, and the product extracted with water, the aqueous solution obtained usually develops a precipitate on prolonged boiling. Formerly, this precipitate was allowed to remain in the alkaline liquid. In the present experiments it was filtered off and added to the acid liquid, in which it readily dissolved.

After extracting the sodium carbonate melt with water, the residue was formerly dissolved in hydrochloric acid, any silica which separated being allowed to remain in the liquid. In the present experiments this, too, was filtered off, and fused again with soda, the treatment being repeated if necessary, until everything had been got into solution. It was thought possible that the undissolved matter might be prejudicial to complete extraction of the emanation. But no such effect seems traceable in the results, and the trouble of preparing the solutions is greatly increased.

In other respects the method of experimenting was the same as before. The standardisations were carried out with several different analysed specimens of uranium ores, with fairly concordant results.

The mean values obtained from several readings with each rock were as follows:—

Description.	Radium per gramme, in grammes $\times 10^{-12}$.
Coarse-grained basalt. Hightown, near Belfast	0·16
Fine-grained basalt. Oelberg, Siebengebirge	0·33
Fine-grained basalt. Tobermory, Mull.....	0·35
Olivine basalt. Talisker Bay, Skye	0·57

These results are even lower than those obtained before for similar rocks. The actual material is different, except in the case of the last rock on the list, which gives about the same result as before.*

* This was the only one of the original basalts examined of which I had enough left for examination.

Thus the difference between my results and Prof. Joly's is somewhat emphasised. I should have regarded my results, if they stood alone, as sufficiently conclusive, though it is impossible to help feeling disconcerted by want of agreement with so distinguished an experimenter. It is perhaps possible, after all, that the difference is due to his having met with exceptional specimens.

Measurements of the Rate at which Helium is Produced in Thorianite and Pitchblende, with a Minimum Estimate of their Antiquity.

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§ 1.—*Introductory.*

The method of deducing a minor limit to the age of minerals from an examination of their radioactive properties has, up to the present time, depended on a measurement of the amount of helium they now contain, and on an indirect calculation of the rate at which it is being produced by the radioactive matter within them.

There is not now much uncertainty about this calculation. Nevertheless, considering the fundamental importance of the question of geological time, it is not superfluous to determine in some favourable case by direct volume-measurement of the gas how much helium is produced per gramme of the mineral per annum, in order to see how long the quantity found in the natural mineral would take to accumulate, and to check the method of calculation to which we must still resort where the much more difficult direct method is impracticable.

A mineral suitable for such experiments must be obtainable by the kilogramme, and very radioactive, so as to give a measurable quantity of helium in a few months. The minerals selected have been thorianite (two varieties) and pitchblende—practically the only ones available.

Some account of preliminary work was given in a former paper.* Much more elaborate and satisfactory experiments have since been carried out. These will now be described.

* 'Roy. Soc. Proc.,' A, vol. 83, p. 98.